Recent Progress in PS2 Collimation Studies

LIS Section Meeting

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Outline

- **Lattice Version**
- **Collimation Layout**
- **One/two stage collimation system**
- **Material**
- **Beam loss Maps**
- **Beta Beating**
- **Closed Orbit Distortion**
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Lattice Version

- **NMC lattice with high γ_{tr}**

Optical Parameters

$Q_x = 15.71$ $Q_y = 13.81$

$\xi_x = \xi_y = 0$

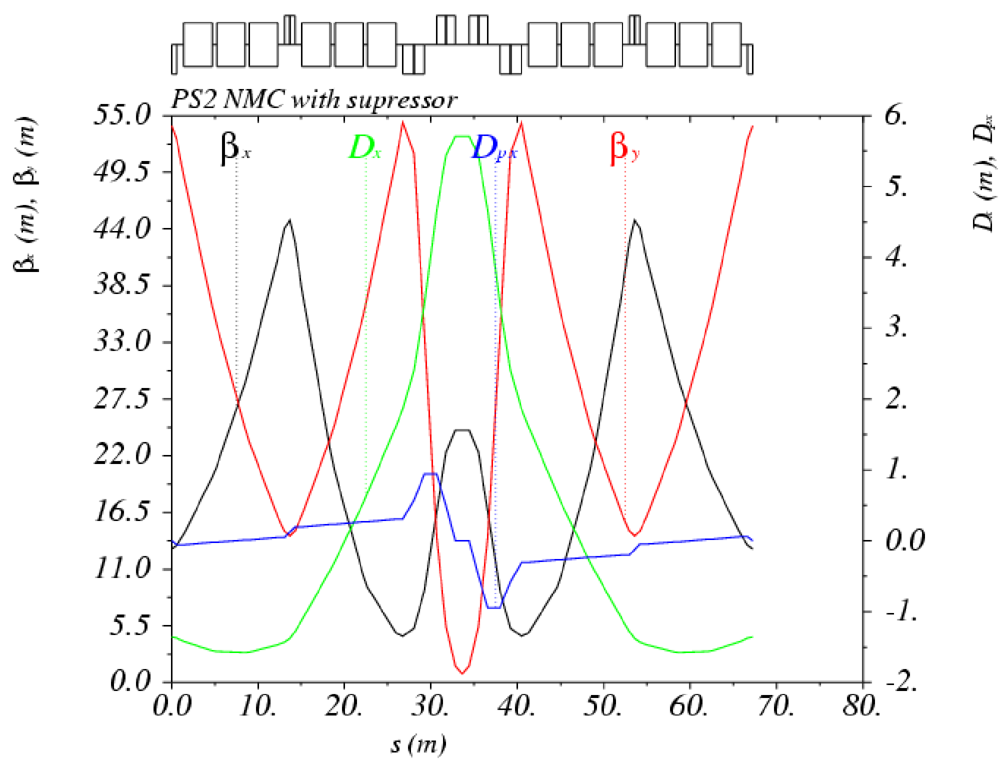
$\gamma_{tr} = \underline{21i}$

Apertures($\varepsilon_{x,n}$=15μm $\varepsilon_{y,n}$=8μm)*

	H/V(mm)
Dipole	(60,50)
Quadrupole	(65,65)

$$A_{x,y} = k_\beta(N_{x,y}\sigma_{x,y} + D_x\frac{\delta p}{p}) + CO_{x,y} + \delta^m_{x,y} + \delta^{al}_{x,y} \;^{**}$$

Optics of the NMC module



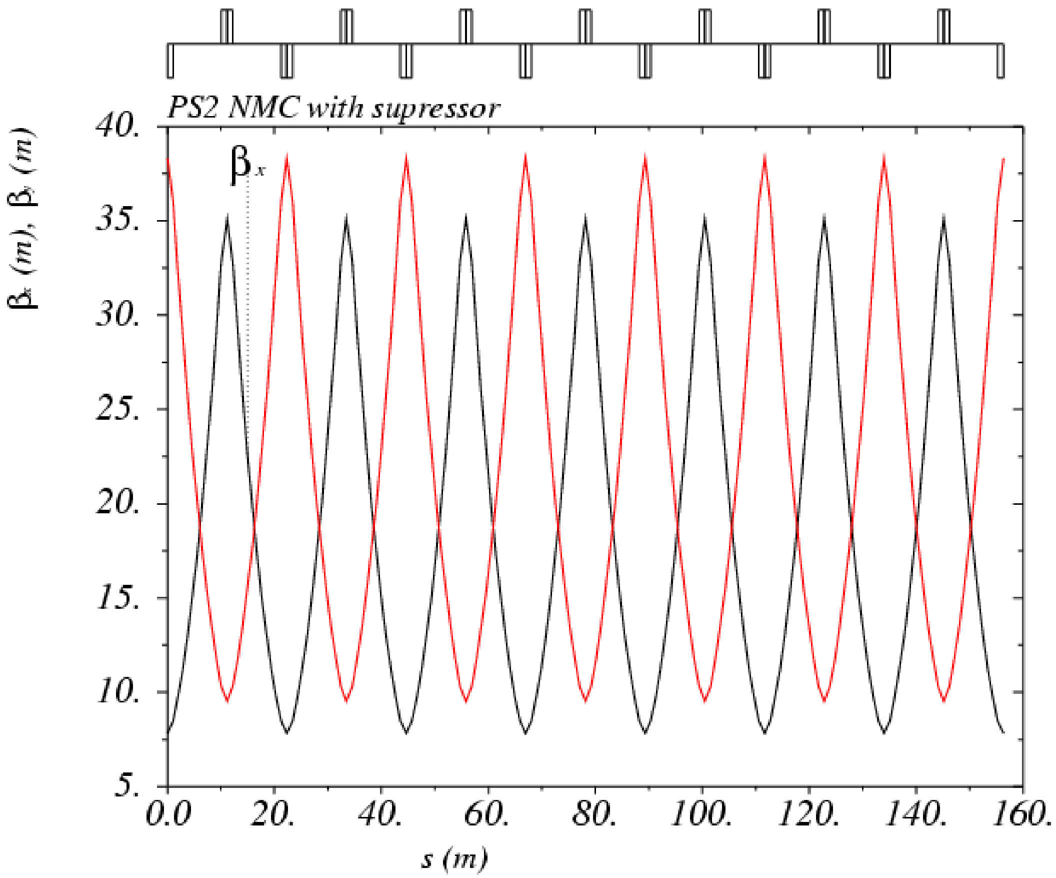
*Courtesy of M. Benedikt "PS2 Parameters"

**J. B. Jeanneret, LHC-NOTE-111

Lattice Version

- **NMC lattice with high γ_{tr}**

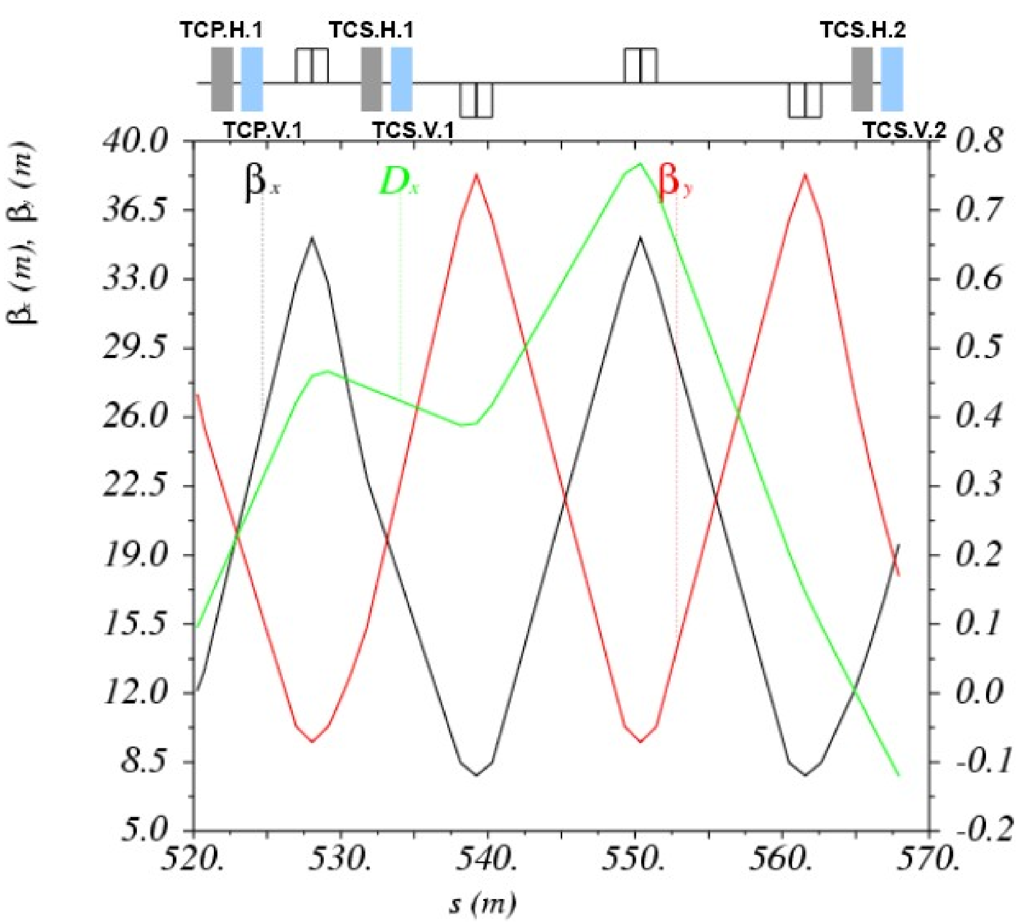
Straight Section FODO type (7 cells)



Collimation Layout

According to the optimal phase advance formula, considering n_{prim}=3.5 σ and n_{sec}=4.0 σ, the secondaries will be located at μ_{opt}=28, 152°.
The similar phase advance in both planes allows to place hor/ver in the same locations (this may change for the new straight section configuration).
No injection/extraction elements are considered in the straight section.

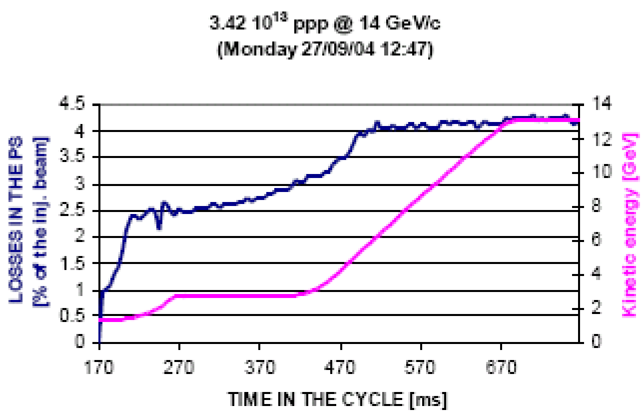
$$\mu_{opt} = \cos^{-1}\left(\frac{n_1}{n_2}\right)$$



Reminder PS Case

From PS an order of magnitude for halo formation could be 3% of the injected beam (losses observed in the PS CNGS beam from injection to extraction wrt to the total current).

PS Case



Beam	% Losses of injected beam (*)(**)	Intensity 10^{13} (ppp)
CNGS	*3.2 %*	*3.42*
SFTPRO	*3.0 %*	*1.47*
LHC	*3.0 % (1^{st} inj)* *1.5 % (2^{nd} inj)*	*0.92*
AD	*4.5 %*	*1.5*
nTOF	*10.0 %*	*0.79*

(*)Thanks to E. Metral (work done for BLRWG. Chaired by G. Arduini)

(**) Losses without considering injection and extraction processes.

- Scale losses from PS will be a preliminary estimation of PS2 losses.
- CNGS beam is the most critical, meaning **3% losses** of the injected beam.
- Extrapolating the 3 % of losses for the CNGS beam to the PS2 case gives (considering distributed losses)

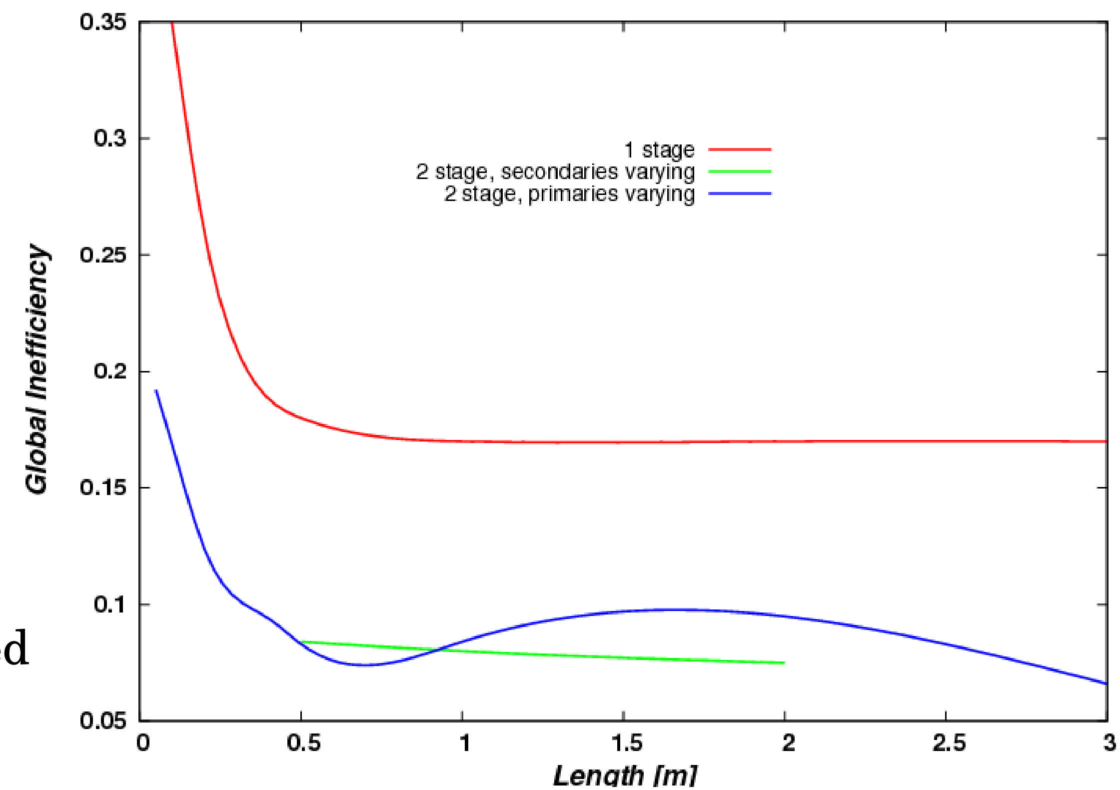
4 GeV	0.7 W/m
50 GeV	**9.4 W/m**
Intregating all over the cycle	**~3 W/m**

- In order to fullfill 1W/m (considering distributed losses), PS2 uncontrolled losses should be kept below 3 10^{-3} → **10^{-3}.**

One/Two Stage Collimation System

One stage collimation system reach an optimum of 18% global inefficiency.
Adding a second stage system improves the global inefficiency down to ~7% losses of the halo simulated.

$$Ineff = \frac{\dot{N}_{p,lost}}{\dot{N}_{p,total}}$$



Red – One Stage System

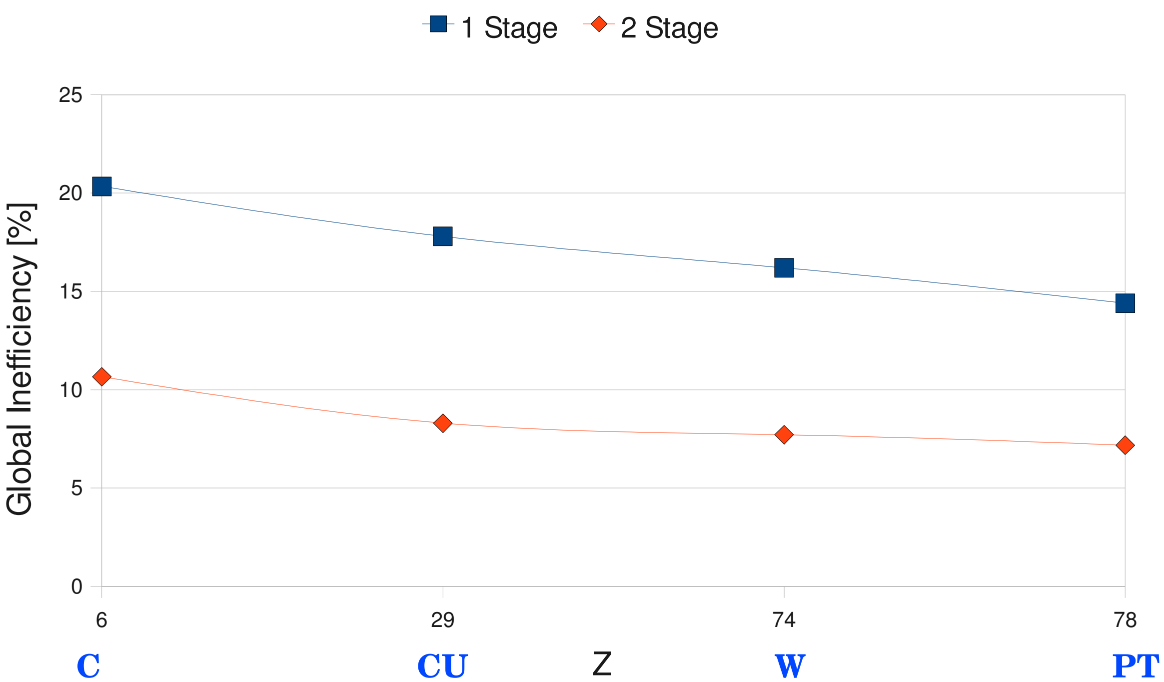
Green – Two Stages System (1ries fixed length 1 m, 2ries various lengths)

Blue – Two Stages System (2ries fixed length 1 m, 1ries various lengths)

Material

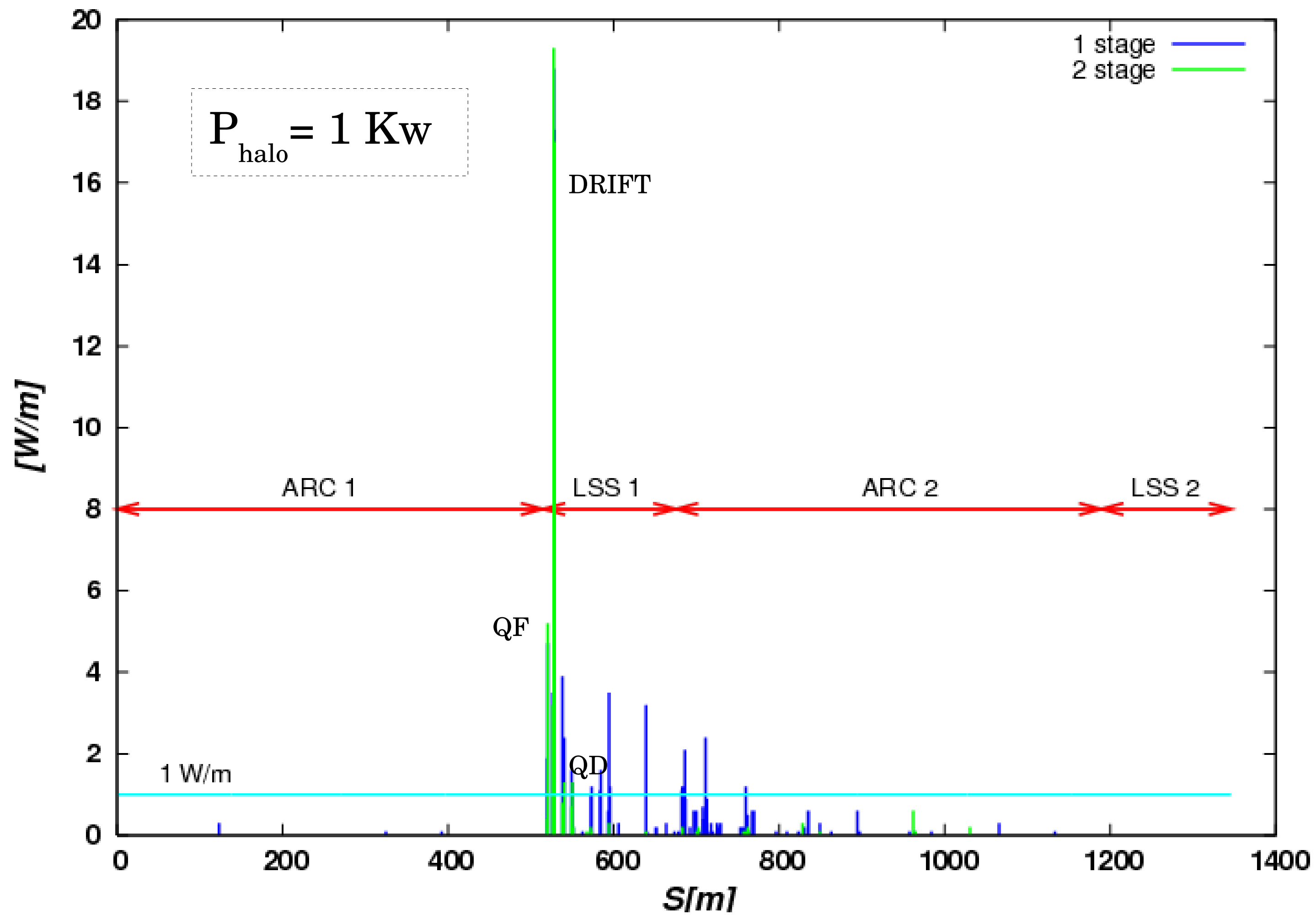
The global inefficiency improves with the increase of the atomic number of the material used. On the other hand energy deposition and activation studies are necessary to take a decision.

Simulations performed for different materials, considering for each simulation the same material for 1^{ries} and 2^{ries}.



Beam Loss Maps

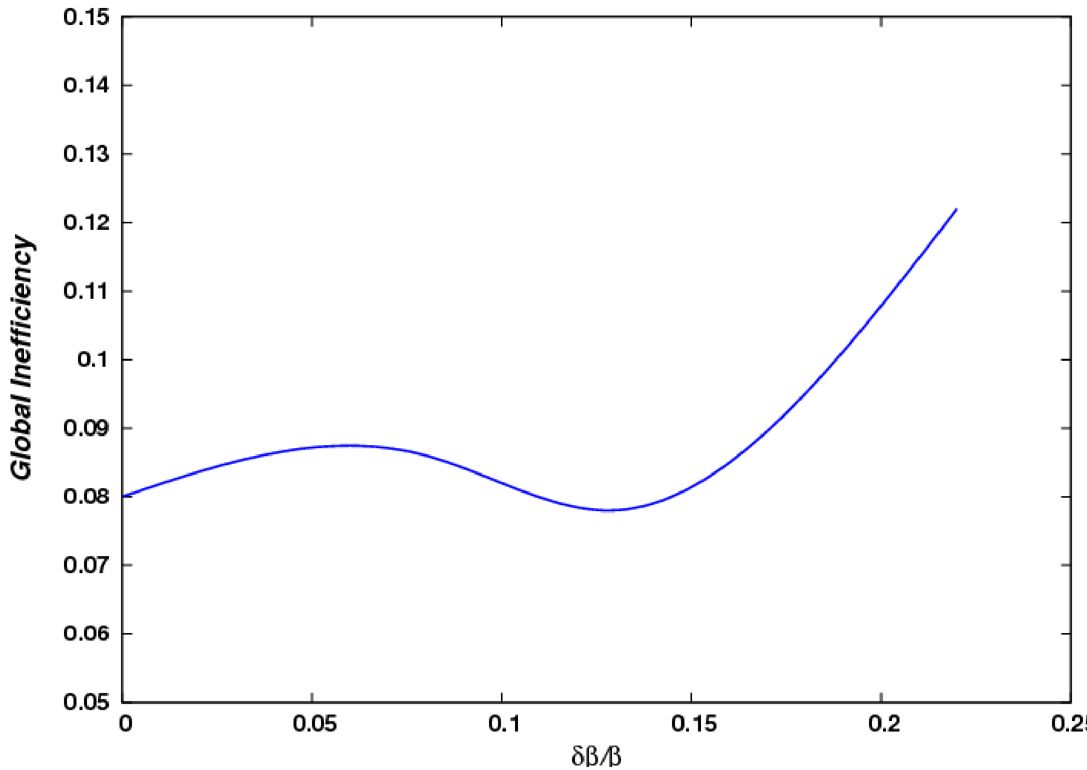
Beam loss map studies show that for the 2 stage case losses are concentrated in the region of the collimators. The 1 W/m consideration is fulfilled everywhere but right after the collimators.



Beta Beating

Assign random relative field errors to Quadrupoles. Worse case is pictured (with respect to maximum beta beating)

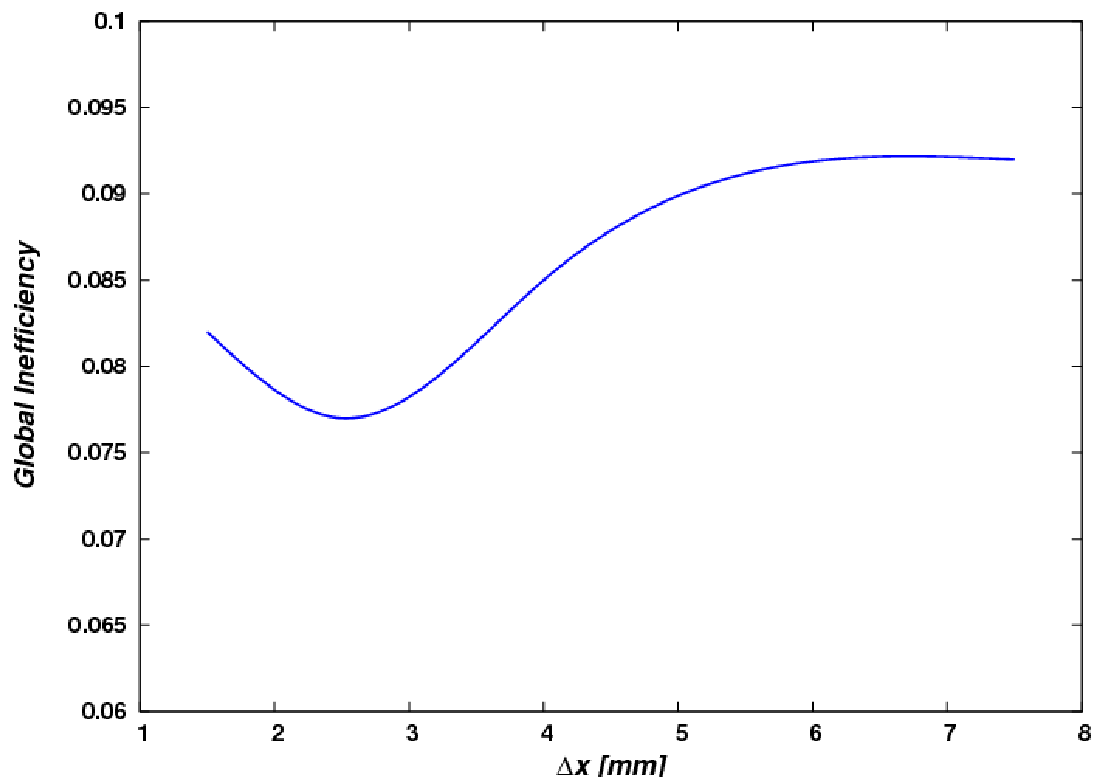
dknr:={0,1E-4*(100*TGAUSS(3))} [m^{-2}]



Beta beating does not affect dramatically the global inefficiency for small values of $\delta\beta/\beta$. For values greater than 10 % the inefficiency starts growing significantly.

Closed Orbit Distortion

Assign random relative displacements in both axis. Worse case is pictured (with respect to maximum orbit distortion)



EALIGN,
DX:=N_x*TGAUSS(3),
DY:=N_y*TGAUSS(3); [m]

Closed orbit does not affect dramatically the global inefficiency going up to a maximum of 9%.

Work in Progress

- Latest lattice version (531 + new straight section).
- All injection/extraction elements included with approximate apertures.
- Repeat similar studies (beta beating, orbit distortion, loss maps,etc.)
- ORBIT simulations to estimate halo formation.